Gretina array: simulated design and performance

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Gretina is 1/4 of the γ-ray energy tracking detector array GRETA [1], and is the first phase of a staged approach towards the construction of the full array. The design and performance of the Gretina detector system have been investigated through detailed Monte Carlo simulations performed with the code Geant 3.21.

Gretina consists of 10 modules each comprising 3 HPGe coaxial crystals placed in a common cryostat. Each crystal has a partially tapered hexagonal shape (8 cm diameter and 9 cm length, before tapering) with a tapering angle of about 10 degrees. The 10 modules can be arranged in a number of ways depending on the physics requirements.

Two proposed configurations for Gretina are: (1) a symmetric arrangement clustered tightly around 0 or 180 degrees with respect to the beam, with an angular coverage of 17 degrees to 55 degrees; (2) an asymmetric arrangement, which extends the angular coverage from 17 to 101 degrees. The first configuration offers a more compact solution with the minimum edge effect, while the second provides the capability to perform angular distribution measurements.

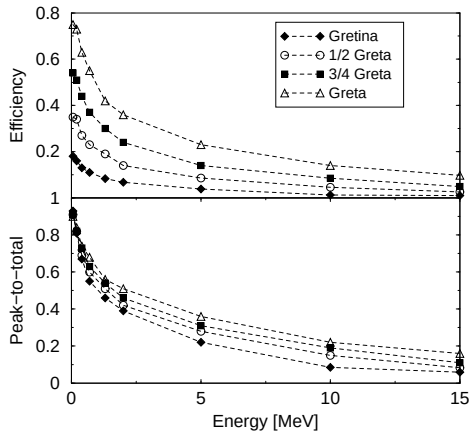

FIG. 1: Photo peak efficiency and peak-to-total ratio as a function of the gamma-ray energy for Gretina in the two possible configurations and Gammasphere.

In the simulations, due to the complex geometry of the real array and the geometrical limitations imposed by the Geant 3.21 code, some simplifications have been used: (1) the array is built from single detectors and not from triple cluster modules; (2) an average inter-crystal gap and an average Al can thickness was used to take into account the different gap sizes between Ge crystals in the same cryostat (small gap = 4.5 mm) or between different cryostats (large gap = 10 mm), and the differences in the thickness of the Al can (0.8 mm) and that of the Al cryostat (1.1 mm). The following dimensions were used: an average Ge-Ge gap of 7.8 mm, an average Ge-Al gap of 1.9 mm, an average Al-Al gap of 1.5 mm, and a total Al thickness of 3 mm.

Using the above approximations the total solid angle coverage was calculated to be $\sim$80% of 4π for GRETA and $\sim$19% for Gretina.

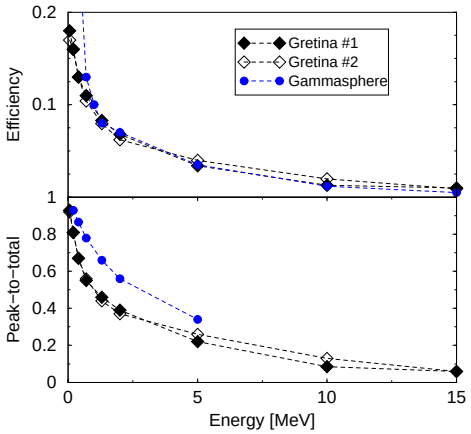

FIG. 2: Photo peak efficiency and peak-to-total ratio as a function of the gamma-ray energy for different stages of the GRETA array.

The photo peak efficiency and peak-to-total ratio calculated as a function of the gamma-ray is given in figure 1 for the four proposed stages of GRETA, and in figure 2 it is compared to Gammasphere. These results were obtained by summing all the interaction points produced by the Monte Carlo simulation for multiplicity M=1 and therefore they represent a maximum.

* *This work has been carried out in collaboration with the GRETA steering committee.*

[1] "GRETA: utilizing new concepts in γ-ray detection", Nucl. Inst. Meth. A430, (1999) 292, M.A. Deleplanque, I.Y. Lee, K. Vetter, G.J. Schmidt, F.S. Stephens, R.M. Clark, R.M. Diamond, P. Fallon, A.O. Macchiavelli.